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# Quality Assurance in Diagnostic Radiology:

## A Guide for State Program Implementation

## A Report on the Task Force

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The opinions and statements contained in this report are those of the Task Force and may not reflect the views of the Department Health and Human Services (HHS).

## FOREWORD

Efforts to reduce unnecessary radiation exposure in the healing arts and minimize health care costs have been stressed by Federal agencies, professional societies and individual States for the past several years. A method to achieve this goal was developed in the early 1970's and tested extensively since then. This method is referred to as "Quality Assurance," (Q.A.).

Realizing the potential benefits of implementing quality assurance in diagnostic x-ray facilities, the Conference of Radiation Control Program Directors' Executive Board authorized the formation of a task force in 1976 to study various aspects of Q.A. The specific charges given the task force were:

1. To define the areas that use diagnostic x ray which require quality assurance and to describe the basic factors to be included in quality assurance programs.

2. To examine current diagnostic x-ray quality assurance programs in Federal agencies and serve as a focal point for State input into these programs.

3. To report to the Conference on quality assurance programs and techniques that could be utilized by the State radiation programs.

This document is designed to educate State program personnel in the concepts of Q.A. and to encourage them to assist medical diagnostic x-ray facilities in implementing Q.A.

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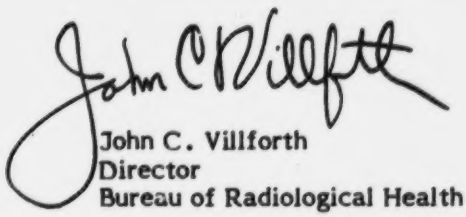

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## PREFACE

This guide has been developed by the Task Force on Quality Assurance at the direction of the Conference of Radiation Control Program Directors. The primary objective of Quality Assurance (Q.A.) is to reduce unnecessary radiation exposure in medical diagnostic x-ray facilities. However, there are two (2) important secondary objectives. They are: (1) to establish and maintain consistent high quality radiographs and (2) to decrease operational costs in x-ray departments by reducing examination retakes and film rejects. There are obvious benefits in accomplishing these objectives. Interpretation of exposed films by medical practitioners will be enhanced for crucial decisionmaking based on examination results. Hospital administrators and medical clinic managers can realize cost savings by reducing the use of equipment, materials and supplies per patient examination. The radiographic process operation can be made more efficient and patient throughput can be increased. Everyone should be interested in reducing the incidence of cancer and other illnesses associated with unnecessary radiation exposure.

This document defines Q.A. and discusses the basic methodologies which can be used by States to encourage and assist medical diagnostic x-ray facilities to establish voluntary Q.A. programs.

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# QUALITY ASSURANCE IN DIAGNOSTIC RADIOLOGY: A GUIDE FOR STATE PROGRAM IMPLEMENTATION

## WHAT IS QUALITY ASSURANCE?

As used in this guide, quality assurance (Q.A.) means the planned and systematic actions that provide adequate confidence that a diagnostic x-ray facility will produce consistently high-quality radiographs at minimum cost and minimum patient exposure.

## WHAT IS A STATE QUALITY ASSURANCE PROGRAM?

Simply stated, a State quality assurance program (SQAP) consists of "consulting actions" that can be taken by a State radiation control agency which, when implemented by a medical facility, should result in the optimization of radiographic procedures and reduction of costs due to the minimization of retakes and the elimination of unnecessary radiographs.

These consulting actions usually place the State in the role of "selling" the need for establishing Q.A. procedures at each facility. Various methods of selling the program are discussed in this document. Ideally, Q.A. procedures should be conducted by "in-house" personnel at each medical facility, some on a continual basis and others periodically. A few procedures should be conducted weekly--even daily--to maintain continuous optimal performance of the radiographic process.

State personnel must receive training in the Q.A. procedures in order to be conversant with medical facility personnel and able to make measurements at the facility to demonstrate the need of a Q.A. program. Currently, training is available through the Bureau of Radiological Health, Rockville, Maryland and many x-ray film and equipment manufacturers.

Q.A. is a long-range program in which results may not necessarily be identified immediately, but only after several weeks or months of making measurements and recording data. State personnel cannot implement or maintain a Q.A. program for a facility; they can only encourage the establishment of a facility Q.A. program, however, it is reasonable that State personnel will periodically assist the facility to understand and solve problems encountered or assist in interpreting Q.A. program results. The success of a Q.A. program is not guaranteed by its implementation, it requires a diligent effort which involves continuous review and analysis of data. Thus, the SQAP effort is designed to be voluntary rather than regulatory —a program in which State personnel would approach the medical facility offering both consultation and assistance and the likely long-range cost-benefits of a Q.A. program.

## WHY SHOULD A STATE RADIATION CONTROL AGENCY IMPLEMENT A Q.A. PROGRAM?

Most States presently have regulations which require that diagnostic x-ray facilities meet established standards for the protection of the operator, patient, and environment. These regulations address areas in which radiation exposure can easily be reduced. It has been demonstrated, however, that the regulations of most State regulatory programs do not address the entire problem of radiation exposure. Existing regulations are directed primarily toward the electrical and mechanical aspects of the x-ray machines and often do not touch the operational aspects of the machines which are controlled by personnel. However, there are many areas in which certain actions can be taken by the State radiation control agency, which would result in significant exposure reduction to patients but do not

necessarily relate to compliance actions. By establishing an SQAP, it provides the State the opportunity to review all the nonregulatory operational aspects of radiology which might significantly impact on patient exposure to unnecessary radiation.

In fact, these nonregulatory actions may result in greater exposure reductions than would compliance actions. The benefits of such nonregulatory actions are discussed below.

## EXPOSURE REDUCTION

There are several aspects of quality assurance that lead to exposure reduction. Reduction of unnecessary patient exposure can generally be correlated to an anticipated reduction of radiation-induced cancers or genetic or somatic mutations resulting from unproductive radiation exposure.

Radiation exposure reduction per radiographic examination is an important benefit of a Q.A. program. If one examines data from NEXT (National Evaluation X-ray Trends) surveys for a given examination, it can be observed that there is a considerable variation in exposure per film (up to a factor of 10 or 100 depending upon the examination). It must be presumed that acceptable radiographs have been produced even at these unusually high exposures. If the causes of these higher exposures can be identified, and controlled or eliminated without adversely affecting the image quality, then the exposure delivered for an acceptable film will be reduced. As a specific example of actual measured exposures for the period from 1972 when NEXT was implemented to the end of 1976, the NEXT data showed that the minimum exposure for abdominal exams was 33 mR; the maximum, 4,852 mR. Twenty-five percent of the films produced for this projection were taken with exposures exceeding 772 mR. These higher exposures may be directly related to poor quality control of machine or processing variables, or both. If quality assurance programs were implemented for these examinations so that none was greater than 772, then the mean exposure for these total abdominal exams would be reduced from 644 mR to 555 mR, a reduction of approximately 14 percent. The reduction for the highest exposure would be 84 percent.

An excellent example of a Q.A. program which has been effective in reducing exposure of the patient is the quality assurance program known as DENT (Dental Exposure Normalization Technique). DENT has achieved an average exposure reduction of 40 percent at those dental facilities which were giving excessively high exposures before the program was implemented. The BENT (Breast Exposure: Nationwide Trends) program has also been effective in dose reduction to the patient and improvement of image quality for mammography examinations.

In addition to these programs, Illinois reduced dental bitewing exposures by 40 percent between 1972 and 1979 by implementing patient exposure limits and recommended levels. The major contribution to this decrease was the emphasis placed on making dental professionals and assistants aware of improved radiographic techniques and procedures.

## RETAKES

Reduction of retakes in an x-ray facility is one of the primary benefits of a Q.A. program. For every radiograph for which a retake is required, the exposure to the patient is, in essence, doubled. Such reduction also benefits the facility directly in terms of decreased cost. Studies of reject rates in diagnostic x-ray facilities have estimated the reject rate to be about 13 percent with reported values ranging from 2 percent to 46 percent (Hall, C.L. Economic Analysis of a Quality Control Program, SPIE, Vol. 127, Optical Instrumentation in Medicine, VI, pp. 271-275, 1977). The reject rate is defined as the total repeat radiographs and blank films divided by the total films used. In general, a reject rate is slightly greater than a repeat rate. The average repeat rate reported for this same study was 9 percent. Facilities without quality assurance programs typically fall into the higher

portion of the range. Some retakes are unavoidable (those due to motion, those resulting from human error that can be minimized but not eliminated, and those due to changes in equipment before such changes are noted and corrected). However, limiting the retake rate to 3 to 5 percent is a reasonable goal.

A sample study of the institution of one film processor quality assurance program indicated the following: the initial cost for equipment to perform this film processor quality assurance program was about $1,000. As a result of the Q.A. program the retake rate dropped from 6.4 percent to 5.2 percent, resulting in the elimination of 1,800 retakes per year. At a projected retake cost of $3.50 (film and chemicals - $1.00, personnel - $1.25, equipment and other supplies - $1.25), the first year's net savings for the program were $3,500, since the initial equipment cost of $1,000 would apply only to the first year, the net savings for the second and succeeding years would be approximately $6,300 annually. (Goldman et al. Automatic Processing Q.A. Program: Impact on a Radiology Department, Radiology 125: 3: 591-595, 1977.) This program was instituted in a facility which had a retake rate of only 6.4 percent before the quality assurance program. In a facility with a somewhat higher initial retake rate, considerably greater savings would be realized.

It is necessary to review retake studies with caution. A low overall retake rate in a facility may be the result of either consistent high quality radiography resulting from good quality control, or the acceptance of poor quality radiography by the facility. Undue pressure on facilities to reduce their retake rate may result in wider acceptance limits rather than corrections in the radiographic system.

## IMPROVED IMAGE QUALITY

The quality of radiographic images ranges from diagnostically useless to excellent. Poor images usually result in retakes. A radiograph may be classified as adequate if that radiograph provides the minimum information necessary for diagnosis of the disease or problem under study. However, an excellent or improved image may not only provide information for the disease or problem under study, but may also provide information which can be used by the diagnostician to discover other unsuspected problems. A quality assurance program can result in more radiographs which fall in the excellent category.

## CONSISTENT PRODUCTION OF QUALITY RADIOGRAPHS

Experience has shown that within a given facility, radiographs which have been produced on different machines or developed through different processors often do not have the same degree of quality. A quality assurance program can identify the sources of variation and indicate the measures that should be taken to correct the situation, thus producing consistent radiographs throughout the facility.

To determine whether the implementation of a quality assurance program is appropriate for your State radiation control agency, answer the following questions:

1. Should you reduce compliance reinspection of a facility if only minor items of noncompliance have consistently been found after several inspections?

2. Are there medical x-ray facilities in your State that meet every regulation but continue to expose patients to unnecessary radiation? As an example, if exposure guidelines have been accepted by your agency, are there facilities which are in compliance with the regulations, yet consistently exceed these guidelines?

3. Do you find that problems not covered by regulations, but for which recommendations were made, are still uncorrected after successive visits to the same facility?

4. Do you know the retake rate of facilities within your State? If you know the retake rate, could it be reduced by methods other than enforcement actions?

5. Would a method to demonstrate "quality" in the radiographic process be valuable to your program activities?

6. Would a program which could measure and demonstrate program effectiveness be helpful to your State radiation control agency for budgetary or other purposes?

If your answer to any of the above questions is "yes," you should consider an "SQAP" in your State. If you answered yes to most of the above questions, a nonregulatory supplement to your regulatory program will, without question, be more effective in the reduction of patient exposure than the regulatory enforcement program alone.

## PROGRAM IMPLEMENTATION

This section of the guide outlines the steps necessary to initiate Q.A. in your State radiation control program.

A Q.A. action program can be implemented in a variety of ways depending upon your degree of involvement. You, as the radiation control program director, and your staff must decide the degree of involvement consistent with your present resources of manpower and equipment. To actively participate in a Q.A. program, you may need to reallocate resources. You may need to shift your emphasis from concentrating on regulatory inspection of radiation equipment or from other non-x-ray program areas. This is not to say that you should discontinue your regulatory program. You should incorporate Q.A. action steps in conjunction with your regulatory program. The result will be a demonstrable impact on facilities and a measure of effectiveness of your radiation control program. The following three levels of participation are examples of possible involvement in Q.A. These levels are neither all inclusive, nor are they mutually exclusive. You may wish to attempt more than one approach or a combination of any of the suggested levels.

## LEVELS OF PARTICIPATION

### LOW-LEVEL

A letter can be sent to those facilities which have been identified as needing a Q.A. program. This mail promotion would describe what Q.A. is and how the program can be used to reduce patient exposure, improve image quality, reduce retake rates and decrease operational costs.

A sample letter is in Appendix I. The letter endorses and presents information on the State's interest and involvement in Q.A. Endorsements from the State's Medical Society and especially the Radiological Society are also recommended. The American College of Radiology (A.C.R.) and the American Association of Physicists in Medicine (A.A.P.M.) are also interested in and have promoted the benefits of Q.A.

### INTERMEDIATE-LEVEL

An individual within the State program should be assigned the responsibility for encouraging facilities to establish Q.A. programs. This individual can be familiarized with Q.A. techniques through specific training from BRH or other organizations and can use

promotional audiovisual materials (Appendix II) for assistance in promoting Q.A. Personal visits should be made to the facilities identified as needing Q.A. and a demonstration with this material will show that Q.A. would be effective for that facility.

When an individual has been fully trained and is then considered the "Q.A. specialist" in the State program, the specialist may utilize various methods to promote Q.A. One method is to utilize these promotional materials directly in an attempt to convince facilities, on a one-on-one basis, that their radiographic department would be enhanced by the adoption of a quality assurance program. Another approach is to conduct workshops for technologists throughout the State to provide an opportunity for experience with quality assurance techniques and equipment. Still another approach is to present talks at local and statewide meetings of technologists and radiologists. Talks could also be given at schools of radiologic technology.

Once a State program has decided to participate at this level, the program director must recognize that a shift in priority activities may be involved since an individual in the State program will need to be trained and will then be devoting a percentage of his time toward Q.A. promotion.

### HIGH-LEVEL

One or more individuals in the State program should be identified and trained as Q.A. specialists. The basic difference between this level and the intermediate level is that the Q.A. specialist will actually perform measurements at medical facilities and offer recommendations for corrective action to optimize the imaging process. The specialist will also demonstrate the equipment and techniques involved in Q.A.

Performing measurements may require the State program to procure additional equipment. The difference in cost between the high and intermediate level will be one of capital outlay plus some additional personnel time within the facility to perform the measurements. At this level the quality assurance specialist will perform one or more measurements for the facility using the State-owned equipment to identify specific problem areas in the radiographic system (x-ray machine, film processing, film screen contact, and so forth). Problems identified by these measurements should be corrected by the facility. Routine measurements provided by a facility quality assurance program would more quickly identify additional problems so the facility could correct such problems and prevent retakes and overexposures.

After the direct measurements have been performed, the Q.A. specialist should then demonstrate the value of a total Q.A. program to the facility. It would be assumed during this presentation the Q.A. specialist would specifically identify problems through the measurements.

## DETERMINING LEVEL OF PARTICIPATION

For total optimization of radiographic exposures, every x-ray facility within a State should be involved in some type of quality assurance program. Low-level participation is recommended as a minimum for every State radiation control program. This level involves a minimum of State resources. The intermediate and high-level participation requires substantially more resources.

It is advisable for a State to set its priorities so that those facilities which have larger workloads (i.e., hospitals, large medical clinics, and so forth) would be visited first. This approach would have more impact on total numbers of patients exposed. Another approach to intermediate and high-level participation is to examine various data that may be available to the State program to detect problem facilities.

## IDENTIFICATION OF PROBLEM FACILITIES

One method of identifying facilities in particular need of quality assurance is to examine currently available inspection data (NEXT, compliance or other.)

### NEXT DATA

If you participate in NEXT, exposure values for given facilities and specific examinations can be compared with the values listed in Table 1. If an individual value for any identified projection exceeds the value listed in Table 1, that facility may be in need of quality assurance. If exposure values for several projections from a facility exceed the values in Table 1, that facility is a high priority candidate for quality assurance.

Table 1. Q.A. action levels by examination*

| Examination | Exposure at skin entrance (mR) |
|---|---|
| Skull (LAT) | 310 |
| Abdomen (KUB)(AP) | 770 |
| Retrograde pyelogram | 920 |
| Lumbar-sacral spine (AP) | 1,000 |

*This data represents all States' NEXT data. A State may choose to use its own NEXT data for action level guides. These skin entrance data represent the third quartile NEXT data from all States as of 1/79.

### COMPLIANCE PROBLEMS

Your compliance data can be examined for indications of facilities in need of quality assurance programs. If a facility has records of repeated violations for the same aspect of performance on the same machine, it is likely that facility is not being very conscientious about its x-ray equipment, including film processors. This type of facility would also be a high priority candidate for quality assurance.

### OTHER CONSIDERATIONS

Without the NEXT or compliance data from surveys or inspections, priority of quality assurance program implementation efforts may be based on:

a. Size of facility, that is, number of beds in a hospital.
b. Workload of facility, based on questionnaire to x-ray facility.

### QUESTIONNAIRE RESPONSE

Send questionnaires to selected facilities, typically high workload facilities. The purpose of the questionnaire is to determine the current involvement of the facility in Q.A. activities and whether the facility would be receptive to State assistance in extending or upgrading its quality assurance program (Appendix III).

## SURVEY FOLLOWUP

Information regarding Q.A. activities within facilities can be obtained by each x-ray inspector, as an adjunct to his regulatory inspection activities (Appendix IV).

## MEASUREMENT PARAMETERS

There are three basic measurements that should be performed on the radiographic equipment. These are:

(1) Patient exposure measurements,
(2) X-ray machine exposure reproducibility measurements, and
(3) X-ray machine exposure linearity measurements.

The patient exposure measurements can be obtained directly from the results of a NEXT survey. If you do not routinely perform NEXT surveys in conjunction with your inspections, it will be necessary to perform measurements in a manner consistent with the NEXT procedure to assure proper geometry so the patient exposure measurements will be comparable to the values listed in Table 1.

Data on x-ray machine parameters should be available from results of routine compliance inspections. Generally, most compliance surveys give an excellent idea of whether the machine is performing in a consistent, satisfactory manner or whether maintenance is required. If such data are not available, then periodic Q.A. measurements of the machine parameter should be performed.

The second part of the radiographic system, which can be evaluated in conjunction with your routine inspections, is the film processor. During an inspection, two measurements on the processor can be performed which will indicate whether the processor is operating properly. The simplest single best check of processor performance is to accurately measure the temperature of the developer solution in the processor and compare it with that recommended by the manufacturer for the given film-chemistry-processor system. For example, if the processor is running cooler than the manufacturer recommends, then unnecessary exposure will have to be administered to each patient in order to obtain proper density on the film. If the temperature of the processor can be increased to that recommended by the manufacturer, exposures can be reduced.

A second method is a sensitometric evaluation of the processor. A sensitometer can be used with the facility's x-ray film to construct a sensitometric curve that is a function of the film as well as the processing normally used in that facility. Film from the facility should be exposed with the sensitometer and developed in the normal manner. By plotting the density values and comparing them with a standard curve for this x-ray film, one can estimate whether or not the processor is performing properly. At present, it is difficult to generate specific sensitometric measurement ranges of acceptability for various films, chemistry and processor combinations. Therefore, even though this parameter is considered important, the results are technically difficult to evaluate.

Any of the above baseline parameters are good measurements on which to evaluate the Q.A. of any facility. However, attention is directed to the fact all data has to be collected over a period of time. SQAP personnel can be of the most assistance to the directors of facility Q.A. programs by pointing out the need to periodically review Q.A. measurements as the primary means to detect operational deficiencies and equipment malfunctions. A review of Q.A. measurement data should also disclose possible problems in the facilities radiographic image optimization endeavours.

Additional secondary parameters may be measured to determine either short-term or long-range problems and inconsistencies in the x-ray machines and/or automatic processors which affect image quality and patient exposure. These parameters are considered "secondary" measurements as opposed to the baseline parameters discussed above.

Secondary parameters include:

1. kVp accuracy
2. Timer accuracy
3. Half-value layer (HVL)

The secondary processing parameters are:

1. Timer/temperature accuracy
2. Film fog
3. Film/screen contact
4. Film/screen compatibility
5. Processing equipment preventive maintenance

If a State program wishes to become more involved with determining variables in the radiographic process, the following third level parameters may be measured:

| Machine parameters | Processing parameters |
|---|---|
| Light/x-ray congruence | Chemical replenishment accuracy |
| Beam/film size | Developer chemistry (age & consistency) |
| SID accuracy | pH of solution |
| Grid integrity | Specific gravity of solution |
| Central ray alignment | Water purity |
| Focal spot size | |
| Central ray (perpendicular) | |

Recommended acceptable ranges or limits for these parameters have not yet been universally established; however, State program personnel may desire to collect data and establish reasonable guidelines for evaluation.

By measuring the parameters indicated above, a State radiation control program can adequately determine the specific need for implementation or improvements in an existing Q.A. program at a medical facility. Of course, as more research is completed and more data collected in the Q.A. field, other measurement parameters may be recommended.

The most important point to be considered is that each State radiation control program must "get involved" to achieve the overall goal of each State program--reduction of patient exposure to the lowest practicable and enhancement of the radiographic image to the highest level for maximum benefit to the patient.

## IMPLEMENTATION COSTS

It is expected that the benefits of implementing the various methods of involvement are contingent on the amount of time and money expended. Low-level participation requires far less time and money than do the other levels, especially high level; however, the benefits or anticipated effectiveness should increase by allocating more time to the program. Table 2 provides projected costs and effectiveness of the different levels of participation.

Table 2. Cost-benefit of the levels of participation

| Level | Action | Est. cost per action per facility | Est. staff time per action per facility | Estimated effectiveness* |
|---|---|---|---|---|
| Low | Promotional letter | $ 1 | 10 minutes | Less than 10% |
| Inter-mediate | Personal presentation of Q.A. benefit directly to facility, workshops, etc. | $100 | 1/2 to 1 day | Greater than 25% |
| High | Send out a Q.A. expert to perform a full Q.A. test of a facility followed by promotional demonstration | $300** | 1 to 1-1/2 days | Greater than 50% |

*This represents the expected positive response from a facility (i.e., 10%, or 10 out of 100 facilities, would actually implement some type of Q.A. program).

**This value does not include cost of capital outlay for test equipment. It is estimated that the capital outlay cost will range from $400 to $5,000, depending upon the extent of participation and the sophistication of the equipment selected.

Minimum equipment costs are necessary for either intermediate or high participation levels. An estimate of these costs is indicated in Table 3 below.

Table 3. Minimum Q.A. measurement equipment*

| Field item (for each Q.A. specialist) | | Cost (est.) | Weight (est.) |
|---|---|---|---|
| -MDH+ | | $2,800 | 16 |
| -Test stand | | 700 | 10 |
| -A/C cassette | | 400 | 6 |
| -Stop watch | | 30 | Insignificant |
| -Digital thermometer | | 40 | Insignificant |
| -Stepwedge | | 40 | 2 |
| -F/S contact test mesh | | 50 | 1 |
| -Sensitometer | | 300 | 5 |
| -Densitometer | | 340 | 3 |
| | TOTAL | $4,700 | 43 lbs. |

*For a complete equipment list, refer to Diagnostic Radiologic Quality Assurance Catalog, U.S. Department of Health and Human Services, Public Health Service, Food & Drug Administration, Bureau of Radiological Health, Rockville, Maryland 20857.

Other comparable ion chamber instruments may be substituted; however, if they do not have exposure time testing capability, a timer-checker must be added to the kit.

The following specialized equipment may be useful to document sensitometry measurements as a laboratory method in addition to the field sensitometry equipment:

Laboratory equipment

| | |
|---|---|
| -Sensitometer | $ 300 |
| -Densitometer | 700 |
| TOTAL | $1,000 |

If the cost of the quality assurance efforts has been estimated and compared with the commitment which the program manager can make to quality assurance, then the decision can be made to either reduce or increase the originally envisioned level by adding or subtracting facilities from the quality assurance effort. The decision as to which facilities are added or removed can be based upon factors such as high workload, degree of compliance with State regulations, the magnitude of exposures as measured by NEXT, or some other specific information which may be available to the program manager. As a result of this analysis, the final decision as to the degree of participation by the State in a quality assurance program may be a combination of the action levels listed above.

## ACTIVITY EVALUATION

The previous sections of this guide have discussed methods for implementation of a Q.A. program in diagnostic x-ray facilities. The actions identified in this guide range from the simple promotion of quality assurance in x-ray facilities by correspondence to rather comprehensive quality assurance activities in facilities, including both direct measurements by the State and one-to-one promotion at a facility by State representatives.

To evaluate the overall effectiveness of quality assurance in diagnostic x-ray facilities, the major standards of success are whether or not the State has been able to:

1. Improve the quality assurance program in facilities which had a minimum program initially, and

2. Initiate a quality assurance program in those facilities where Q.A. was virtually nonexistent.

Although the institution of a Q.A. program in a facility, or the improvement of an existing program is the primary measure of success, a secondary measure of success by the State is the actual detection or determination of a problem in a facility by the State's "Q.A. Specialist" and if some improvement was accomplished as a result of the Q.A. specialist's efforts.

## METHODS OF EVALUATION

### LOW-LEVEL PARTICIPATION

Under the minimum level of participation the major objective is to stimulate the initiation or improvement of quality assurance programs within x-ray facilities. Therefore, to evaluate this phase of participation, following the mailing of promotional letters and literature to the x-ray facilities, a representative sample of the facilities should be contacted by representatives of the radiation control programs to determine:

1. If the facility received the letter and promotional material, and if so, whether it was reviewed by:

   a. The hospital administrator
   b. The radiologist
   c. The technologist.

2. What action was taken by the facility to either improve or initiate a quality assurance program, assuming that the appropriate persons within the facility received the letter and promotional material.

## INTERMEDIATE-LEVEL PARTICIPATION

The objective again is to promote the initiation or improvement of quality assurance programs in x-ray facilities. The basic difference in this level as compared with the low level is that there is actual personal visitation by the State's "Quality Assurance Specialist" with the promotional program. Again, the method for evaluating the effectiveness of this effort will be to review a representative sample after facilities have had sufficient time to either initiate or improve existing quality assurance programs.

## HIGH-LEVEL PARTICIPATION

Under this level of participation, the primary objective of initiating or improving quality assurance programs can be evaluated on a basis similar to that in the low and intermediate levels. However, since this category also involves measurements by the Quality Assurance Specialist of the State, records should be maintained as to the problems which have been found and corrected. With the use of this data, statistics can be developed which will reflect specific problems found and corrective actions recommended by the State representative.

The bottom line of the evaluation for any of the participation levels rests with information concerning the attainment of the original objectives. As stated in the introduction of this guide, the objectives are:

1. To reduce unnecessary radiation exposure;

2. To establish and maintain consistent high quality radiographs; and

3. To decrease operational costs in x-ray departments.

Therefore, data must be collected, reviewed, and analyzed to reflect effectiveness. Facility success can be directly applied to the SQAP success if the facility success is a result of State effort. Documentation is needed for at least one of the following objectives to measure success:

1. Percentage of unnecessary radiation exposure reduction.

2. Percentage of film retake reduction.

3. Actual cost savings at facilities.

4. Quality improvement of radiographs as determined by medical practitioners.

5. Improvement of overall efficiency in the radiographic process by enhanced patient throughput.

Baseline data must be recorded at each facility to compare future followup data for determination of results. Any effort made by the State to implement Q.A. in a facility must include a suggestion to the facility that a set of records be maintained to evaluate progress and effectiveness. These records should include, as a minimum, the following items:

A. General Records

   1. Charts pertaining to the retake rate change within a facility.

2. Charts pertaining to the entrance skin exposure

    a. Range
    b. Reproducibility

B. Machine Parameters

1. Exposure

    a. Reproducibility
    b. Linearity within mA stations

2. Accuracy of technique factors

    a. kVp
    b. Timer
    c. mA
    d. mAs

C. Film Processing Parameters

1. Optical Density

    a. Reproducibility

2. Contrast

3. Developer immersion time

4. Temperature

## APPENDIX I

## EXAMPLE OF PROMOTIONAL LETTER

### SAMPLE LETTER

(It is recommended that the sample letter below be sent directly to the chief radiologist of the facility in question, with a carbon of this letter being addressed to the Administrator of the facility.)

Dear Doctor Mr. (Administrator) _____:

You may have read about the benefits of Quality Assurance (Q.A.) programs in diagnostic radiology. A good quality assurance program may provide a substantial savings in materials and staff time in your radiology department. Quality assurance programs will also improve the efficiency within your facility, and help to provide consistent, high quality radiographic images for your (or your radiologist's) interpretation.

Your general impression may be that initiating a quality assurance program requires a major investment in equipment or a fee for professional quality assurance service. Considerable expenditure of funds for testing equipment and extra time from certain personnel within your facility or a contract with a professional quality assurance service may be required for large medical facilities having a very high patient workload. However, the overall savings to the facility when a comprehensive quality assurance program is implemented, will be considerably greater than the cost of implementation. A total comprehensive quality assurance program may not be required for smaller facilities to realize improvement in radiographic quality and a financial savings to the facility. As an example, for a facility in which 100,000 radiographs per year are taken, the estimated range of initial cost for implementing a quality assurance program is between $2,000 and $5,000. As a result of the Q.A. program in this particular facility, the financial savings from retake reduction would be an estimated minimum of $6,000 annually.

Your department may already have a quality assurance program, in which case you are already aware of the benefits to be gained by such activities. However, if you would like assistance in either implementing a Q.A. program, or upgrading your present quality assurance program,—(at this point, the State may choose two responses in the letter. One response can be to refer interested facilities to professional Q.A. services such as available from film companies and enclose a listing of where these services can be obtained or second, to specifically indicate that your State agency will directly assist the facility in implementing or improving their quality assurance program.)

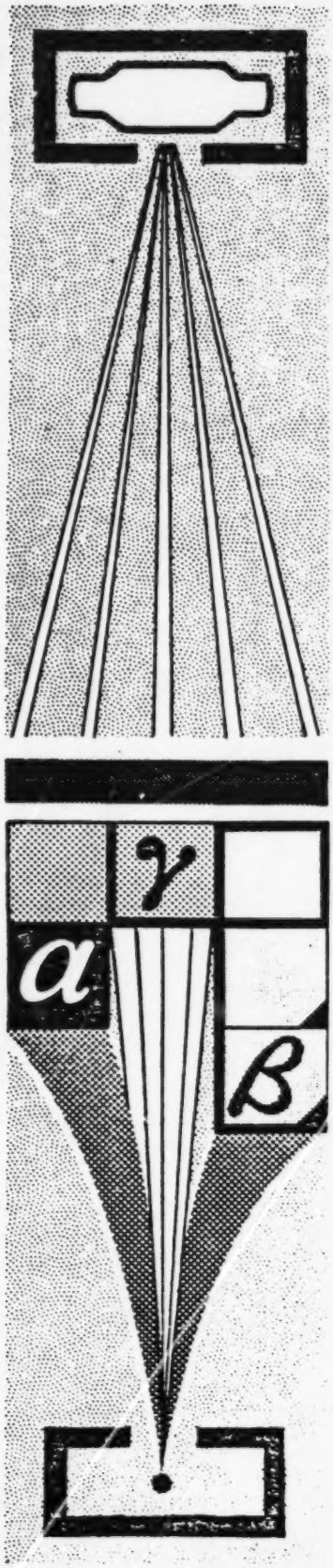
## APPENDIX II

## FACILITY PROMOTION PROCEDURES

State personnel can use materials such as the slide-tape package entitled:

> Radiation Protection During Medical X-Ray Examinations - Part 3: A Basic Program: Quality Control for the Automatic Film Processor

or the enclosed quality assurance kit. This kit originally was planned as a "cookbook" presentation; however, results of pilot testing have demonstrated that its major usefulness is as a guide and suggested format for presentation rather than a substitute for the individual quality assurance specialist.




# RADIOGRAPHIC QUALITY ASSURANCE

ORIENTATION MANUAL

Produced By
Bureau Radiological Health
Food and Drug Administration
in cooperation with
National Conference of Radiation Control Program Directors, Inc.

# Introduction

The Division of Training and Medical Applications of the Bureau of Radiological Health in cooperation with the Conference of Radiation Control Program Directors has prepared this presentation to assist you in promoting and encouraging the implementation of a Diagnostic Radiology Quality Assurance Program in the hospitals and clinics under your State's jurisdiction.

Major objectives of the program include a reduction in retakes, cost savings, improved radiographic quality, increased efficiency, and minimum patient exposure.

Your role as State Inspector is vital to the success of the program. The decision-makers in hospitals, clinics and other facilities which operate radiographic and processing equipment must be made aware of the benefits of this program and accept the need for a Quality Assurance Program. These results will be primarily through your efforts.

The presentation materials incorporate the following features:

- Flexible method of delivery
- Portability and convenience
- Practical approach
- Minimum time requirement
- Consideration of key personnel associated with the program

The presentation materials are designed to identify and motivate the facility to implement a Radiographic Quality Assurance Program. Emphasis is placed on the minimal cost of implementation and the resultant savings of materials, staff time and dollars.

A comprehensive Quality Assurance Program includes the proper operation of radiographic equipment and of the film processor so that high quality radiographs may be produced. Since the processor is critical to high quality imaging, and since one processor may affect the production of several radiographic laboratories, the logical place to begin the program is with the automatic processor.

Radiographic equipment maintenance factors appear to be less likely to cause poor radiographic quality than film processing. Although each facility should institute a comprehensive program to minimize repeats from all causes, the immediate goal is to remedy the major source of repeats—the automatic processor.

Once the Processor Quality Assurance Program has been installed, the facility should be ready to discuss the "Phasing In" of the equipment maintenance schedule which will produce additional benefits.

The program is a professional approach to the production of high quality radiographs. It is a program which every hospital administrator and member of the radiology team should welcome. The program does not add a burden to an already intensive staff schedule - it provides a systematic solution to a problem which has the benefits of saving time, material, money - and contributing to improved patient care.

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(Computing The Analysis Worksheet)

## RADIOGRAPHIC QUALITY ASSURANCE

## PRESENTATION KIT

CONTENTS:

Your kit includes the following materials:

1. "Flip Chart" Presentation Notebook. This "Flip Chart" Notebook contains the visual portion of your audio visual presentation material. These visuals are designed to reinforce and visually clarify the audio or narrative portion of the presentation. The notebook contains the visuals for your presentation to three levels of radiology personnel:

| | |
|---|---|
| Hospital Administrator | (Unit I) |
| Radiologist | (Unit II) |
| Radiographic Technologist | (Unit III) |

2. Audio Presentation Cassette. The Audio Cassette contains a recorded narrative for the three presentations. It should be used by the State inspector to become familiar with the material to be presented and the proper method of presentation. In a presentation to personnel at a medical facility, the State inspector may choose to make the verbal presentation himself or use the tape.

3. Orientation Manual. The document you are now reading is your Orientation Manual. It will show you how to present the audio visual programs, give you step-by-step procedures for presenting the program and provide you with background materials to assist you in the presentation.

4. Sample Copies of Manuals and Other Support Materials. These are quality assurance materials that have been designed to answer the needs of hospitals and clinics planning to implement a program. The material was carefully designed to assist related personnel in the key areas of implementing and maintaining a proven program.

5. Cost Benefit Analysis Folder. This "File Folder" was designed to assist you in pointing out the benefits and potential cost savings involved in establishing a Quality Assurance Program.

   The folder will be turned over to the Hospital Administrator as a graphic reminder of potential cost savings and as a central point to preserve related information. A step-by-step procedure for developing the cost analysis will be found in the Appendix of this manual.

6. File Folder with Cost Analysis and Benefits Analysis. The File Folder is a convenient and useful reference for the Hospital Administrator. The pre-printed tab assures that the folder will be properly filed and will be easily noticed in the filing system. The Cost Analysis Worksheet provides the Hospital Administrator with the projected cost savings the Quality Assurance Program would provide for his facility. The analysis will be computed from data which you will secure before your appointed visit or immediately upon your arrival at the facility. (The computation will be illustrated later in this booklet.) The File Folder will be completed and left with the Hospital Administrator. Additional worksheets are included in your kit for personal use or for copies to be given to other members of the radiology team.

   The Cost Benefit Analysis is intended to be used in facilities which have no Processor Quality Assurance Program. You will not need to use this form in those few instances where a Processor Quality Assurance Program is installed. Unfortunately, no cost figures for Equipment Quality Assurance Programs are available. Your presentation to facilities which have a Processor Quality Assurance Program will emphasize benefits of an Equipment Maintenance Program.

## PROCEDURES

### PRE-PRESENTATION PROCEDURES:

1. Talk with the facility radiologist to determine the present level of quality assurance used by the radiographic personnel.

2. Collect from the radiologist the data you will need to complete a Cost Benefit Analysis with the Hospital Administrator.

3. Arrange an appointment with the Administrator to present the concept.

### PRESENTATION PROCEDURE:

#### Hospital Administrator

1. Present Unit I to the Hospital Administrator.

2. Using the data you collected from the Radioligist, complete a Cost Benefit Analysis with the Administrator.

3. Show the Administrator the support materials that are available with this program. Emphasize that these materials represent programs that now exist in other facilities. This is a complete package that involves a small financial obligation - and that initial funding will be recovered in a matter of weeks through savings in time and materials.

4. Answer any questions the Administrator might have.

5. Show the Administrator Units II and III if he wishes to see the material you will be presenting to his staff.

6. Prepare and deliver the file folder with related manuals and other information as a permanent reference on Radiographic Quality Assurance.

## Radiologist

1. Arrange a presentation to the Staff Radiologist.

2. Present both Units I and II to the Radiologist.

3. Answer any questions that the presentation might raise.

4. Talk about the Radiologist's specific needs and problems.

5. Encourage the Radiologist to discuss the program with the Administrator.

## Radiographic Technologists

1. Arrange a presentation to the Radiographic Technologists.

2. Show the Technologists Units I, II and III.

3. Answer any questions that the presentation might raise.

4. Talk with the staff about their specific needs and problems.

5. Encourage them to discuss the program with the Administrator.

6. Discuss the steps which may be taken to implement a program in the facility.

POST-PRESENTATION PROCEDURE:

1. Follow up as necessary, to encourage each facility to adopt the program.

2. Make necessary contacts to secure the materials the facilities will need for training and implementation.

## HOSPITAL ADMINISTRATOR PRESENTATION

Major points covered in Part I of the "Flip-Folder" and "Audio Tape".

1. Maintain a minimal dosage of patient exposure to radiation
   a. Lowest setting consistent with high quality radiographs.
   b. Reduced repeats minimizes exposure to radiation.

2. Cost Effectiveness
   a. Reduced material costs.
   b. Reduced personnel costs - Time savings to Technologists and Radiologists in repeats.
   c. Maintenance costs reduced through proper identification of system failures.

3. Increase Efficiency of Radiology Department
   a. Increase patient flow.
   b. Consistent and, therefore, quicker delivery of high quality, acceptable radiographs.
   c. Predictable radiographic quality.

4. Reduced patient inconvenience. Fewer returns to Radiology for repeats.

5. The program is recommended by many Government and professional groups and is part of the JCAH requirements for hospital accreditation.

6. The program applies the newest technology in Radiographic Quality Assurance.

## RADIOLOGIST PRESENTATION

Part II of the Flip-Folder and Audio Tape appeals to the Radiologists' need to protect patients from unnecessary exposure to radiation, to deliver quickly the highest quality radiograph, and to improve departmental efficiency.

"NEEDS" OF THE CHIEF RADIOLOGIST THE PRESENTATION ADDRESSES:

1. Minimizes patient exposure to radiation.

2. Reduces materials costs - possible use of savings for additional equipment, personnel, etc.

3. Increases patient flow.

4. The program provides a standard against which radiographic quality can be measured.

5. The program aids in determining apparent defects in the processor or other radiological equipment which leads to the decreased possibility of unnecessary and costly service calls for inaccurately diagnosed equipment problems.

6. The program utilizes existing staff and requires a minimum of staff time.

7. The program can be implemented easily.

THE CHIEF RADIOLOGIST'S PRESENTATION FOCUSES ON THE FOLLOWING AREAS TO EMPHASIZE THE ABOVE STATED ITEMS:

1. Concern for radiation dosage. Eliminates the need to increase the mAs to produce a quality radiograph.

2. Increases departmental efficiency.

3. Eliminates the variable caused by a processor which is operating out of specification.

4. Simple process establishes a daily standard of operational quality.

## TECHNOLOGISTS PRESENTATION

(They will view Parts I and II also.)

Part III introduces the program as a simple, time-saving, highly professional approach to the delivery of quality radiographs.

THE NEEDS OF THE TECHNOLOGIST ADDRESSED IN THE PRESENTATION WILL BE:

1. Keep patient radiation exposure to a minimum.

2. Pride in the production of consistently high quality radiographs.

3. Processing problems detected before poor quality requires expensive repeats or complaints from Radiologists and Physicians.

4. Use of an approved and tested program.

5. The daily work load can be more accurately predicted.

6. Technologist will learn the use of new equipment which assures professional, quality production of radiographs.

TO ILLUSTRATE THESE NEEDS THE RADIOLOGISTS' SECTION FOCUSES ON JOB PERFORMANCE.

1. Fewer complaints about radiographic quality.

2. The process is a quick, easy, daily procedure.

3. Fewer demands for repeats allow a more efficient use of the technologist's time.

4. Automatic processors are not "Fool-proof." They are mechanized; they do not think for themselves.

5. As each radiograph is processed the chemical solution changes and quality varies slightly. There is no way to assure consistency except through a testing procedure which has standards of comparison.

## APPENDIX

### COMPUTING THE BENEFIT ANALYSIS WORKSHEET

(Sample Facility Data)

The following procedure is recommended for developing cost benefit data with the Hospital Administrator. The procedure is presented in a step-by-step method.

The following assumed data is typical of an average Radiographic Department. Your judgement will determine the "Typical" data to be applied in your individual locations.

1. Total Radiographs for the year — 50,000

2. Percentage of Repeats — 12% or 5,616

3. Repeats due to processor variables. If not known develop an average calculation.

4. Estimated Technologist's Salary — $15,000

5. Equipment necessary for establishing processor quality control:

| | |
|---|---|
| Densitometer | $1,200 |
| Sensitometer | $ 495 |
| Thermometer | $ 60 |
| | $1,755 |

(Estimate of equipment: The cost estimate for the three pieces of equipment may be more or less depending on the intended use of the equipment for other Quality Assurance Program activities. The cost shown for the Densitometer and Sensitometer in this estimate is slightly high since they could be used in the Radiographic Equipment Quality Assurance Program when it is implemented. Depending on the sophistication of equipment purchased, the cost may range from $600 to $5,000.)

(The following exercise is to familiarize you with the recommended "Step-by-Step" procedure for developing the "Benefit Analysis" section of the File Folder. A copy of the worksheet is necessary to complete this section)

STEP 1

Enter the actual figure or estimate as shown below.

## BENEFIT ANALYSIS WORKSHEET

### RADIOGRAPHIC QUALITY ASSURANCE PROGRAM

STEP 1: TOTAL ANNUAL RADIOGRAPHS (ESTIMATE IF UNKNOWN) (1) 50,000

STEP 2

Compute and enter the "Total Repeats" in (2). In this example 12% of 50,000 or 5616 is used.

STEP 2: TOTAL REPEATS (2) 5,616

| COMPUTE AND ENTER FOR (2) | |
|---|---|
| A. | "REPEAT" % _____ X (1) _____ |
| B. | ASSUMED AVERAGE 12% X (1) _____ |

If an estimate is given to you, compute the total repeats in the computation box and enter the figure in Step 2. For simplicity sake, we have used the estimated figure as 12%.

STEP 2: TOTAL REPEATS (2) 5,616

| COMPUTE AND ENTER FOR (2) | |
|---|---|
| A. | "REPEAT" % 12 X (1) 50,000 |
| B. | ASSUMED AVERAGE 12% X (1) _____ |

If no estimate can be made, use the assumed national average of 12% and compute as follows:

STEP 2: TOTAL REPEATS (2) 5,616

| COMPUTE AND ENTER FOR (2) | |
|---|---|
| A. "REPEAT" % _____ X (1) _____ | |
| B. ASSUMED AVERAGE 12% X (1) | 50,000 |

STEP 3

The facility in our example had no figure or estimate. Most you will discover, will not. If they do, enter the given figure on the line to the right. If they have estimated percentage, calculate the amount in the box and enter on line (3). If they allow you to use the assumed average, calculate as indicated below.

STEP 3: TOTAL REPEATS DUE TO EQUIPMENT VARIABLES (3) 4212

| | |
|---|---|
| A. ESTIMATE % _____ X (2) _____ | |
| B. ASSUMED AVERAGE: 75% X (2) | 5616 |

STEP 4

The cost for film materials and chemicals is given, as is the equipment depreciation costs. The only figure you need to calculate is the Technologist's salary. In the example, the salary is $15,000. From the table, enter on line C the cost of $1.87; and then add A,B, and C. Enter the total on the line to the right at (4)

STEP 4: COST PER RADIOGRAPH (ESTIMATE OR COMPUTE BELOW) (4) $ 4.90

| | | |
|---|---|---|
| A. | FILM MATERIALS AND CHEMICAL COSTS | $1.85 |
| B. | EQUIPMENT DEPRECIATION COST | $1.18 |
| C. | TECHNOLOGIST COST/RADIOGRAPH | $ 1.87 |
| | ENTER TOTAL @ (4) | $ 4.90 |

## TECHNOLOGIST COST TABLE

10,000 EXPOSURES ANNUALLY

| TECHNOLOGIST SALARY | BENEFITS 25% | ANNUAL COST | TECHNOLOGIST COST/RADIOGRAPH |
|---|---|---|---|
| $10,000 | $2,500 | $12,500 | $1.25 |
| 12,000 | 3,000 | 15,000 | 1.50 |
| 15,000 | 3,750 | 18,750 | 1.87 |

STEP 5

The cost of equipment related repeats is found by multiplying the total repeats due to equipment variables (3) times the cost per radiograph (4) to determine the cost of equipment related repeats.

STEP 5: COST OF EQUIPMENT RELATED REPEATS (5) $ 20,638.80

ENTER (3) 4212 X (4) $ 4.90 =

STEP 6

The annual savings can now be determined by multiplying the assumed 60% reduction in equipment related retakes times the total cost of equipment related repeats or $20,638.80. This gives an annual savings amount of $12,383.20.

STEP 6: ANNUAL SAVINGS ASSUMING A 60% REDUCTION IN EQUIPMENT RELATED RETAKES AS A RESULT OF RADIOGRAPHIC QUALITY ASSURANCE PROGRAM

60% X (5) $ 20,638.80 (6) $ 12,383.20

STEP 7

A five year cost saving is projected to allow for equipment depreciation or a five year useful life.

STEP 7: FIVE YEAR COST SAVINGS

5 YEARS X (6) $ 12,383.20 = (7) $ 61,916.00

STEP 8

Enter the cost of needed equipment as previously determined.

STEP 8: SUBTRACT COST OF QUALITY ASSURANCE DEVICES (-) (8) $ 1755.00

| | | |
|---|---|---|
| DENSITOMETER | $ | 1200 |
| SENSITOMETER | $ | 495 |
| THERMOMETER | $ | 60 |
| ENTER TOTAL @ (8) | $ | 1755 |

STEP 9

The adjusted five year cost savings is determined by subtracting the cost of quality assurance devices (8) from the five year savings (7) to obtain the adjusted figure (9).

STEP 9: ADJUSTED FIVE YEAR COST SAVINGS
(7) $ 61,916 MINUS (8) $ 1755. (9) $ 60161.00

You may also wish to point out that this estimate does not include:

1. Time and Salary of the Radiologist

2. Time and Fees of the Physician

3. Nursing Staff Time and Cost to prepare the patient for a repeat

4. Administrative Overhead Costs

5. Records Maintenance Costs

6. Patient Inconvenience and Concern over Radiation Exposure

7. Morale of the Radiology Staff when Poor Radiographs are Produced

## BENEFIT ANALYSIS WORKSHEET

### RADIOGRAPHIC QUALITY ASSURANCE PROGRAM

STEP 1: TOTAL ANNUAL RADIOGRAPHS (ESTIMATE IF UNKNOWN) (1) _____

STEP 2: TOTAL REPEATS (2) _____

| COMPUTE AND ENTER FOR (2) | |
|---|---|
| A. "REPEAT" % _____ X (1) | _____ |
| B. ASSUMED AVERAGE 12% X (1) | _____ |

STEP 3: TOTAL REPEATS DUE TO EQUIPMENT VARIABLES (3) _____

| | |
|---|---|
| A. ESTIMATE % _____ X (2) | _____ |
| B. ASSUMED AVERAGE: 75% X (2) | _____ |

STEP 4: COST PER RADIOGRAPH (ESTIMATE OR COMPUTE BELOW) (4) $ _____

| | | |
|---|---|---|
| A. | FILM MATERIALS AND CHEMICAL COSTS | $1.85 |
| B. | EQUIPMENT DEPRECIATION COST | $1.18 |
| C. | TECHNOLOGIST COST/RADIOGRAPH | $ _____ |
| | ENTER TOTAL @ (4) | $ _____ |

## TECHNOLOGIST COST TABLE

### 10,000 EXPOSURES ANNUALLY

| TECHNOLOGIST SALARY | BENEFITS 25% | ANNUAL COST | TECHNOLOGIST COST/RADIOGRAPH |
|---|---|---|---|
| $10,000 | $2,500 | $12,500 | $1.25 |
| 12,000 | 3,000 | 15,000 | 1.50 |
| 15,000 | 3,750 | 18,750 | 1.87 |

STEP 5: COST OF EQUIPMENT RELATED REPEATS (5) $ _____

ENTER (3) _____ X (4) $ _____ =

STEP 6: ANNUAL SAVINGS ASSUMING A 60% REDUCTION IN EQUIPMENT RELATED RETAKES AS A RESULT OF RADIOGRAPHIC QUALITY ASSURANCE PROGRAM

60% X (5) $ _____ = (6) $ _____

STEP 7: FIVE YEAR COST SAVINGS

5 YEARS X (6) $ _____ = (7) $ _____

STEP 8: SUBTRACT COST OF QUALITY ASSURANCE DEVICES (-) (8) $ _____

| | |
|---|---|
| _____ | $ _____ |
| _____ | $ _____ |
| _____ | $ _____ |
| ENTER TOTAL @ (8) | $ _____ |

STEP 9: ADJUSTED FIVE YEAR COST SAVINGS

(7) $ _____ MINUS (8) $ _____ (9) $ _____

#1 TITLE SLIDE

RADIOGRAPHIC QUALITY ASSURANCE

UNIT 1
ADMINISTRATOR PRESENTATION

**PREDICTABILITY**

**EFFICIENCY**

#2 A COMPREHENSIVE RADIOGRAPHIC QUALITY ASSURANCE PROGRAM IS HELPING TO ACHIEVE A NEW LEVEL OF PREDICTABILITY AND EFFICIENCY IN RADIOLOGY DEPARTMENTS THROUGH OUT THE COUNTRY.

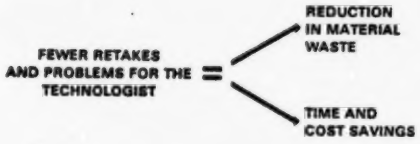
OTHER BENEFITS OF A QUALITY ASSURANCE PROGRAM, WHICH YOU AS THE HOSPITAL ADMINISTRATOR CAN APPRECIATE ARE:

**BENEFIT NO. 1:**

**THE PRODUCTION OF HIGH QUALITY RADIOGRAPHS WITH MINIMUM RADIATION EXPOSURE TO PATIENTS.**

#3 FIRST - THE PRODUCTION OF HIGH QUALITY RADIOGRAPHS WITH MINIMUM RADIATION EXPOSURE TO PATIENTS.

**BENEFIT NO. 2:**

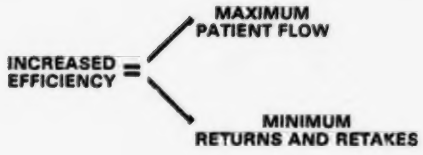



#4 SECOND - FEWER RETAKES AND FEWER PROBLEMS FOR THE TECHNOLOGISTS - WHICH MEANS A REDUCTION IN UNNECESSARY WASTAGE OF MATERIALS AND SIGNIFICANT DOLLAR SAVINGS IN THE HIGH COSTS OF TECHNICAL PERSONNEL AND PROFESSIONAL TIME.

BENEFIT NO. 3

#5 THIRD - FEWER COMPLAINTS ABOUT RADIOGRAPHIC QUALITY - CONSISTENTLY HIGH QUALITY RADIOGRAPHS ALLOW RADIOLOGISTS AND PHYSICIANS TO DIAGNOSE PATIENT PROBLEMS ACCURATELY AND WITH LESS DELAY . . . AND

BENEFIT NO. 4:




#6 FOURTH - INCREASED EFFICIENCY IN THE RADIOLOGY DEPARTMENT BY MAINTAINING MAXIMUM PATIENT FLOW AND ELIMINATING THE INCONVENIENCE OF PATIENTS RETURNING TO THE LABORATORY FOR RETAKES.

EXPOSURE

ECONOMY

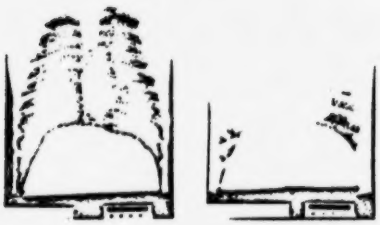
EFFICIENCY

PROFESSIONALISM

#7 A BASIC QUALITY ASSURANCE PROGRAM MAKES GOOD SENSE . . . IT MAINTAINS ACCEPTABLE LEVELS OF PATIENT EXPOSURE TO RADIATION, WITH WHICH WE ARE PARTICULARLY CONCERNED.

IT'S ECONOMICAL - ACTUALLY SAVES YOU MONEY.

IT INCREASES EFFICIENCY . . . AND IT REFLECTS YOUR CONCERN AND DESIRE FOR HIGH PROFESSIONAL STANDARDS IN RADIOLOGY.



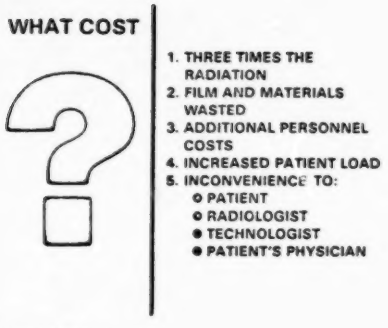
#8 A GOOD EXAMPLE OF THE DIFFERENCE A FILM PROCESSOR QUALITY ASSURANCE PROGRAM CAN MAKE IS ILLUSTRATED BY COMPARING THESE TWO RADIOGRAPHS.

THE ONE OF THE LEFT WAS PRODUCED UNDER OPTIMUM CONDITIONS WITH FRESH CHEMISTRY IN THE PROCESSOR.

THE ONE ON THE RIGHT WAS TAKEN USING THE SAME EXPOSURE TECHNIQUE BUT WAS PROCESSED WITH UNDER-REPLENISHED DEVELOPER- A CONDITION OFTEN ENCOUNTERED IN RADIOLOGY DEPARTMENTS.

A TECHNOLOGIST WOULD NOT SUPPLY THIS RADIOGRAPH TO THE RADIOLOGIST AND WOULD IMMEDIATELY REPEAT THE FILM.

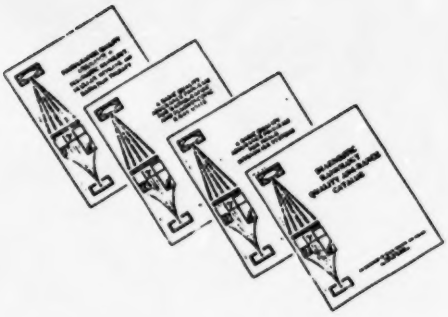
#9 BY DOUBLING THE RADIATION DOSE A RADIOGRAPH SIMILAR TO THE ONE ON THE LEFT WOULD BE PRODUCED USING THE UNDER-REPLENISHED CHEMISTRY . . . SINCE CONTRAST WOULD BE LOW, IT WOULD BE NECESSARY TO LOWER THE KVP AND FURTHER INCREASE THE RADIATION EXPOSURE TO THE PATIENT.



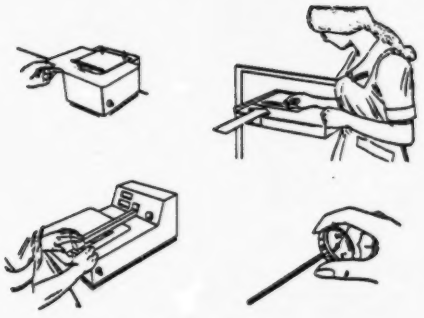

#10 A "SATISFACTORY" RADIOGRAPH WOULD BE PRODUCED, BUT AT WHAT COST? . . .

THE PATIENT RECEIVED THREE TIMES THE NECESSARY RADIATION; FILM AND MATERIALS WASTED; ADDITIONAL COSTS FOR PERSONNEL INCURRED; THE INCREASED PATIENT LOAD IN THE RADIOLOGY DEPARTMENT, AND INCONVENIENCE TO THE PATIENT, THE RADIOLOGIST, THE TECHNOLOGIST, AND THE PATIENT'S PHYSICIAN.

YOU CAN SEE WHY WE ARE ENCOURAGING YOU TO IMPLEMENT A RADIOLOGIC QUALITY CONTROL PROGRAM IN YOUR FACILITY.



#11 TO ASSIST YOU IN INITIATING AN APPROVED QUALITY ASSURANCE PROGRAM THE BUREAU OF RADIOLOGICAL HEALTH HAS PREPARED COMPREHENSIVE MANUALS OUTLINING THE PROCEDURES AND THE EQUIPMENT NECESSARY FOR ESTABLISHING A PHOTOGRAPHIC QUALITY ASSURANCE AND A RADIOGRAPHIC QUALITY ASSURANCE PROGRAM.



#12 THE MANUALS INCLUDE THE "WHATS" . . . "WHYS" AND "HOWS" OF ESTABLISHING AND MAINTAINING A QUALITY ASSURANCE PROGRAM. THE MANUALS AND A CATALOG OF RESOURCES AND EQUIPMENT ARE AVAILABLE AND INCLUDE THE SOURCES AND INSTRUCTIONS.

HOSPITAL ADMINISTRATORS HAVE FOUND THAT SIMPLE QUALITY ASSURANCE PROCEDURES TRANSLATE INTO IMMEDIATE SAVINGS . . . FAR EXCEEDING THE INITIAL COSTS OF ESTABLISHING THE PROGRAM, EVEN THE FIRST YEAR.

**EXAMPLE**

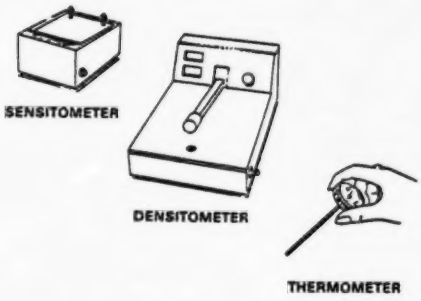
**REPEATS:**
18 RADIOGRAPHS PER DAY

**REDUCTION WITH PHOTOGRAPHIC QUALITY CONTROL**
40%

**TOTAL COST PER RADIOGRAPH:**
$4.40

**ANNUAL SAVINGS:**
@ $4.40 $12,000.00
@ $10.40 $27,000.00

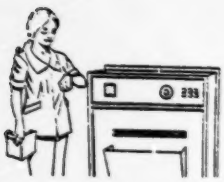
#13 AS AN EXAMPLE . . . AN AVERAGE SIZED X-RAY DEPARTMENT REPEATED ONLY 18 RADIOGRAPHS PER DAY . . . A PHOTOGRAPHIC QUALITY CONTROL PROGRAM CAN PREVENT A LARGE PERCENTAGE OF THESE RETAKES . . . SOME RETAKES WILL BE MADE DUE TO FACTORS OTHER THAN EQUIPMENT VARIANCES. ASSUMING AN AVERAGE COST OF $4.42 FOR FILM, PROCESSING, LABOR AND EQUIPMENT DEPRECIATION, THIS TRANSLATES INTO A SAVINGS OF MORE THAN $12,000 PER YEAR; AND THIS DOES NOT INCLUDE THE LABOR COSTS OF RADIOLOGISTS, PHYSICIANS, AND STAFF TO PREPARE A PATIENT FOR A RETAKE. ONE RECENT STUDY INDICATES THE TOTAL COST PER RADIOGRAPH IS $10.40.




#14 THE COST OF SETTING UP A PHOTOGRAPHIC QUALITY ASSURANCE PROGRAM CAN BE QUITE LOW. ONLY THREE BASIC PIECES OF EQUIPMENT ARE NECESSARY TO ESTABLISH AND MAINTAIN THE PROGRAM.

1. A SENSITOMETER
2. A DENSITOMETER AND
3. A THERMOMETER . . .

REPRESENTING A TOTAL COST FROM $600.00 TO $1700.00. SIMPLE STEP-BY-STEP PROCEDURES ARE CAREFULLY COVERED IN THE MANUAL PREPARED BY THE BUREAU OF RADIOLOGICAL HEALTH.



#15 ONLY A FEW MINUTES PER DAY ARE REQUIRED TO PERFORM THE CHECKS AND RECORD THE DATA - LESS TIME AND COST THAN A SINGLE RETAKE.

THE QUALITY ASSURANCE PROGRAMS FOR RADIOGRAPHIC EQUIPMENT ARE MADE AT THE TIME OF SERVICING OR AT REGULAR, STATED INTERVALS.

#16 MANUALS ARE AVAILABLE WHICH CONTAIN FULL INSTRUCTIONS, PROCEDURES AND DATA.

A QUALITY ASSURANCE PROGRAM PROVIDES NEW LEVELS OF PROFESSIONAL, COST-EFFECTIVE PERFORMANCE . . . INCORPORATING THE OBVIOUS BENEFITS OF -

**REDUCED**

PATIENT DOSAGE
PATIENT INCONVENIENCE
PATIENT CONCERN

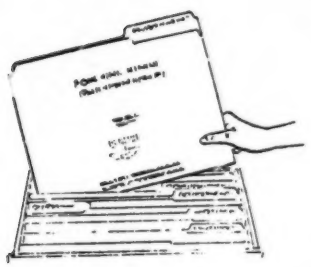
**REDUCED**

MATERIAL COSTS
PERSONNEL COSTS
MAINTENANCE COSTS

**INCREASED**

EFFICIENCY
PATIENT FLOW
PREDICTABILITY

#17 REDUCED PATIENT DOSAGE, INCONVENIENCE, AND CONCERN ABOUT RADIATION; REDUCED MATERIAL, PERSONNEL AND MAINTENANCE COSTS; AND INCREASED EFFICIENCY, PATIENT FLOW, AND PREDICTABILITY OF ACCEPTABLE RADIOGRAPHS.



#18 AT THIS TIME YOU MAY EXAMINE A BREAKDOWN OF THE SAVINGS YOU CAN EXPECT AFTER IMPLEMENTING A QUALITY ASSURANCE PROGRAM IN YOUR RADIOLOGY DEPARTMENT. THIS FILE FOLDER SERVES AS A PERMANENT RECORD OF THE SAVINGS AND BENEFITS OF THE PROGRAM.

#19 TITLE SLIDE
FDA - CHIEF RADIOLOGIST

AS CHIEF RADIOLOGIST, YOUR PARTICIPATION IN A QUALITY ASSURANCE PROGRAM IS A KEY FACTOR IN AN EFFECTIVE PROGRAM.

**NEW LEVEL OF CONTROL**

**PATIENT RADIATION DOSAGE**

**DEPARTMENT OPERATING COSTS**

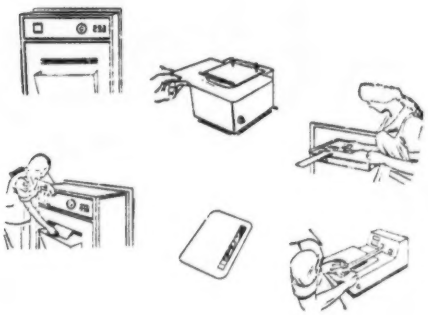
**DEPARTMENT EFFICIENCY**

#20 PATIENT RADIATION DOSAGE, THE OPERATING COSTS OF THE DEPARTMENT AND OVERALL EFFICIENCY ARE DAILY CONCERNS.

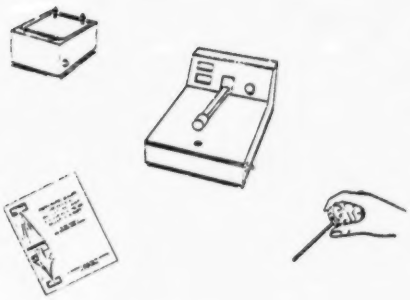
## OBJECTIVES

| EXPECTATIONS | DO NOT WANT |
| --- | --- |
| HIGH QUALITY RADIOGRAPHS | • FLUCTUATIONS IN RADIOGRAPHIC QUALITY<br>• COSTLY NEW PROCEDURES<br>• TIME CONSUMING NEW PROCEDURES. |

#21 YOUR MAJOR CONCERN, HOWEVER, IS THE MAINTENANCE OF CONSISTENTLY HIGH QUALITY RADIOGRAPHS. WHAT YOU DON'T NEED OR WANT ARE FLUCTUATIONS IN RADIOGRAPHIC QUALITY CAUSED BY INCONSISTENT OPERATION OF EQUIPMENT OR THE IMPOSITION OF COSTLY OR TIME-CONSUMING QUALITY CONTROL PROCEDURES.



#22 THE RECOMMENDED PHOTOGRAPHIC QUALITY ASSURANCE PROGRAM IS AN EXAMPLE OF A TESTED AND PROVEN PROGRAM THAT WORKS, IS INEXPENSIVE, AND IS READILY AVAILABLE. THE PROCEDURE CONSISTS OF A SERIES OF SIMPLE, QUICK TESTS FOR ESTABLISHING A DAILY STANDARD FOR PHOTOGRAPHIC PROCESSING. A COMPREHENSIVE PROGRAM, WHICH INCLUDES CHECKS ON THE RADIOGRAPHIC EQUIPMENT, ESTABLISHES STANDARDS FOR EVERY LINK IN THE IMAGE CHAIN.



#23 TO IMPLEMENT THE PROGRAM, BASIC EQUIPMENT MUST BE PURCHASED, IF IT IS NOT PRESENTLY ON HAND, AND CERTAIN PROCEDURES MUST BE IMPLEMENTED AS PART OF THE DAILY ROUTINE.

"BENEFIT"

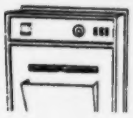
SAVINGS = EQUIPMENT PERSONNEL

#24 IN ADDITION TO THE BENEFITS ALREADY MENTIONED, THE QUALITY ASSURANCE PROGRAM WILL:

1. SAVE YOU MONEY IN YOUR BUDGET WHICH MAY BE USED FOR ADDITIONAL EQUIPMENT OR PERSONNEL. THE INITIAL COST OF THE PROGRAM WILL BE AMORTIZED DURING THE FIRST FEW MONTHS THROUGH SAVINGS ON FILM ALONE.

"BENEFITS"

REDUCE COMPLAINTS
MINIMIZE VARIABLES
MAINTAIN ACCEPTABLE LIMITS



#25 2. IT WILL REDUCE COMPLAINTS ABOUT RADIOGRAPHIC QUALITY BY MINIMIZING THE VARIABLES IN THE IMAGE CHAIN AND KEEP THEM WITHIN ACCEPTABLE LIMITS. MECHANIZED EQUIPMENT IS NOT FOOL-PROOF OR "AUTOMATIC" - ITS PERFORMANCE MUST BY CLOSELY MONITORED . . . WHICH LEADS TO ANOTHER BENEFIT -

"BENEFIT"

PROVIDE ADVANCE WARNING OF MANY MAINTENANCE NEEDS OR POSSIBLE FAILURES.

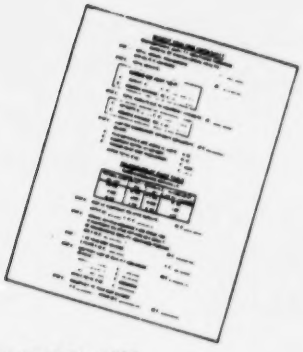
#26 3. IT WILL PROVIDE ADVANCE WARNING OF MANY MAINTENANCE NEEDS OR POSSIBLE FAILURES THAT WILL DISRUPT SERVICE TO PATIENTS;

## BENEFITS

- PREDICTING WORKLOADS AND STAFFING NEEDS MORE ACCURATELY.
- DEVELOP GREATER PRIDE WITHIN THE DEPARTMENT.

#27 4. It will allow you to predict your work load and staffing needs more accurately . . . and

5. It will develop a greater pride within your department through consistent production of high quality radiographs.



#28 To calculate the cost savings that can be realized with a Quality Assurance Program, a minimum amount of data is required:

1. Number of radiographs processed last year or the estimated total for this year.
2. Number or percent of repeats of radiographs processed last year.
3. Number or percent of repeats due to equipment problems.
4. Average salary of technologist.
5. Fringe benefits, and
6. List of Quality Assurance Program equipment needed.

At this time, a brief discussion of the available materials and estimated costs of equipment will assist you in recognizing the benefits of the program in your radiographic department.

#29 TITLE SLIDE
TECHNOLOGISTS' PRESENTATION

#30 AS A RADIOLOGIC TECHNOLOGIST YOU STRIVE FOR RADIOGRAPHS OF CONSISTENT CONTRAST, DENSITY, HIGH QUALITY AND ACCEPTABILITY TO THE RADIOLOGIST AND PHYSICIAN . . . AND . . . CONSISTENCY IS THE RESULT OF ELIMINATING THE PROBLEM CAUSING VARIABLES IN YOUR IMAGING CHAIN.

AS YOU KNOW, THERE ARE A NUMBER OF VARIABLES IN THE IMAGING CHAIN WHICH EFFECT THE RADIOGRAPH.

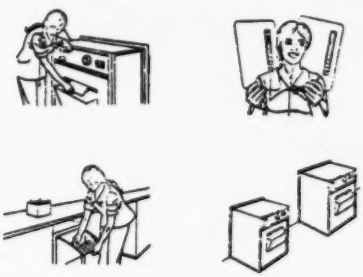
## TECHNIQUE

- TRAINING
- JUDGEMENT
- EXPERIENCE
- EQUIPMENT VARIABLES
  1. FILM PROCESSOR
  2. X-RAY UNITS

#31 THERE IS THE "TECHNIQUE" WHICH IS RELATED TO THE TRAINING, JUDGEMENT AND EXPERIENCE OF THE TECHNOLOGIST AND THERE ARE EQUIPMENT VARIABLES THAT ARE CONTROLLABLE:

1. THE FILM PROCESSOR, AND
2. THE RADIOGRAPHIC AND FLUOROSCOPIC X-RAY UNITS.

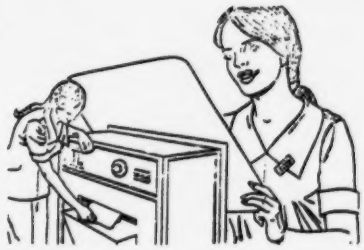
THE TERM "AUTOMATIC PROCESSING" DOES NOT MEAN "AUTOMATIC QUALITY" OR "AUTOMATIC CONSISTENCY" WHEN APPLIED TO FILM PROCESSING.



#32 QUALITY CONTROL IN THIS INSTANCE IS A PROCEDURE TO ELIMINATE FILM PROCESSING AS THE CAUSE OF A HIGH PERCENTAGE OF UNACCEPTABLE RADIOGRAPHS.

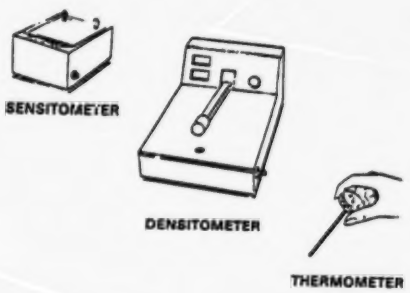
CERTAINLY, OTHER VARIABLES HAVE AN EFFECT ON QUALITY, BUT THE "MECHANIZED PROCESSOR" CAN BE THE "NUMBER ONE CULPRIT", ESPECIALLY WHEN MORE THAN ONE PROCESSOR SERVICES SEVERAL RADIOGRAPHIC UNITS.

IF THIS ONE LINK IN THE CHAIN IS OUT OF SPECIFICATION, A QUARTER MILLION DOLLARS WORTH OF SOPHISTICATED EQUIPMENT WILL NOT PRODUCE CONSISTENTLY HIGH QUALITY RADIOGRAPHS.



#33 LET'S LOOK FOR A MOMENT AT THE QUALITY ASSURANCE PROGRAM FOR THE AUTOMATIC - RATHER MECHANIZED - FILM PROCESSOR WHICH STUDIES INDICATE CAN BE A CAUSE OF A HIGH PERCENTAGE OF REPEATS.

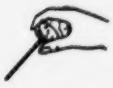
WHAT DOES IT TAKE IN MATERIALS AND TIME TO PERFORM THE DAILY CHECK AND RECORD THE NECESSARY DATA? PHOTOGRAPHIC QUALITY ASSURANCE WILL REQUIRE THREE ITEMS OF EQUIPMENT:




#34 A SENSITOMETER . . . A DENSITOMETER . . . AND A THERMOMETER.

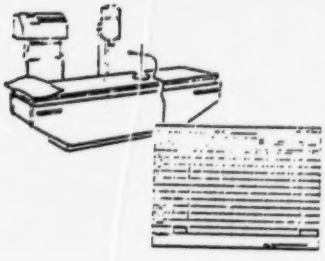
THE SENSITOMETER CONTAINS A LIGHT SOURCE AND A TIMING MECHANISM DESIGNED TO GIVE PRECISE, REPEATABLE AND GRADED LIGHT EXPOSURE TO THE RADIOGRAPHIC FILM.

THE DENSITOMETER IS USED TO MEASURE THE BLACKENING OR THE DENSITY OF THE RADIOGRAPHIC FILM . . . SIMPLE COMPARISONS ARE POSSIBLE ONCE DENSITY STANDARDS ARE ESTABLISHED.

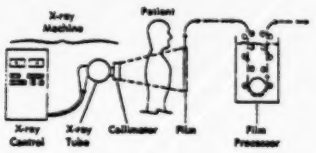


#35 To assure the quality you want and to produce radiographs that are more consistently acceptable, you need only the equipment we've mentioned: a log book to record readings, and less time per day than it takes to drink a cup of coffee.

In addition, your daily schedule will be more predictable and your professional pride in the quality of radiographs you produce will be increased.



#36 The Radiographic and Fluoroscopic X-ray units need formal performance checks as does any piece of equipment. A chart which summarizes the type and the frequency of checks you can make using the Quality Assurance Program for equipment is available.




#37 RADIOGRAPHS REMAIN CONSTANT ONLY IF EACH COMPONENT OF THE RADIOGRAPHIC IMAGING CHAIN - THE LINE VOLTAGE, THE TUBE GENERATOR CALIBRATION, THE X-RAY TUBE, COLLIMATION, SCREEN/FILM COMBINATION, FILM PROCESSOR - REMAINS CONSTANT THROUGHOUT THE DAY AND FROM DAY TO DAY.

**A COMPREHENSIVE QUALITY ASSURANCE PROGRAM WILL REDUCE**

- **RETAKES**
- **PATIENT RADIATION**
- **CRITICISM**
- **TIME**
- **MONEY**

#38 A COMPREHENSIVE QUALITY ASSURANCE PROGRAM WILL REDUCE RETAKES . . . PATIENT RADIATION DOSAGE . . . CRITICISM . . . INVESTMENT OF TIME AND MONEY.

**A QUALITY ASSURANCE PROGRAM PROVIDES YOU:**

1. CONSISTENT QUALITY RADIOGRAPHS
2. REDUCED WORKLOAD
3. MORE TIME TO DO YOUR WORK
4. MORE PROFESSIONAL PRIDE

#39 THE PROGRAM PROVIDES YOU:

1. CONSISTENT QUALITY RADIOGRAPHS,
2. REDUCED WORK LOAD,
3. MORE TIME TO DO YOUR WORK WITHOUT PRESSURE, AND
4. MORE PROFESSIONAL PRIDE.

#40. WE WILL ASSIST YOU IN EVALUATING YOUR PRESENT QUALITY ASSURANCE PROGRAM. YOU NEED TO ASSESS WHERE YOU ARE NOW AND TO DETERMINE HOW YOU PLAN TO PHASE IN THE VARIOUS QUALITY ASSURANCE ACTIVITIES THROUGH A PROGRESSIVE PROGRAM OF IMPLEMENTATION.

THE PROGRAM IS AVAILABLE . . . ENCOURAGE YOUR CHIEF RADIOLOGIST AND HOSPITAL ADMINISTRATOR TO TO MAKE AN INVESTMENT WHICH SAVES.

## APPENDIX III

## EXAMPLE OF QUALITY ASSURANCE QUESTIONNAIRE

Quality assurance in diagnostic radiology can result in better radiographic images, improve staff efficiency, reduce patient exposure, and provide financial savings. The information requested in this questionnaire will enable the (State) Radiation Control Agency to assist you in either initiating a quality assurance program or in improving your existing quality assurance program.

A. Would you like quality assurance assistance from the (State) Radiation Control Agency? _____Yes_____No

B. Film Processing

1. Does your department have a quality assurance program for film processing? _____Yes_____No

   (i.e.) - sensitometry measurement
   - solution temperature measurement

2. If yes, describe the procedure and equipment used:

3. Is it performed by in-house personnel or by commercial personnel? _____In-House_____Commercial

4. How often is film processing performance tested?

C. X-Ray Generator:

1. Does your department have a quality assurance program for x-ray machine performance? _____Yes_____No

2. If yes, is this program performed by in-house or commercial personnel? _____In-House _____Commercial

3. Please list below the type of tests performed, the equipment used and the frequency of testing? (If you have a standard written protocol for testing, you may attach a copy in lieu of this summary.)

D. Ancillary Equipment:

If you routinely perform quality assurance tests on other equipment used in the department (e.g., cassettes), briefly summarize these tests here.

E. Comments:

APPENDIX IV (A)

STATE OF ILLINOIS

FACILITY Q.A. QUESTIONNAIRE

I. Facility - General

1. Facility Name_____

2. Reg. #_____ 3. Date_____ 4. Interviewed_____

5. Phone_____ 6. # of Beds_____ 7. By_____

- - - -

Registration # _____

III. Q.A. - General (cont'd)

2. Why do you think you need Q.A. and what do you hope to accomplish?

3. Did you do any work to determine a need for some Q.A. at your facility? If so, what and how? (i.e., study retakes, re-occurring processor problems, high patient exposures, etc.) Did you use this information to sell Q.A. to your supervisors?

4. a) How many people do you have involved in Q.A. related activities?_____

   b) What percent of their time is spent on Q.A.?_____

   c) How were they trained?_____

   _____

   _____

5. How long did you talk about Q.A. before you got something rolling?_____mo.

6. When did you start doing some form of Q.A. at your facility?_____Date

7. When did you consider your Q.A. program in good operation?_____

8. What does "Quality Assurance" in diagnostic radiology mean to you?

---

IV. Processor Q.A.

| | | | |
|---|---|---|---|
| 1. | Do you have a densitometer? | Yes/No | Sat/Unsat |
| 2. | Do you have a sensitometer? | Yes/No | Sat/Unsat |
| 3. | Do you have a thermometer? | Yes/No | Sat/Unsat |
| 4. | Do you use pre-exposed films from film company? | Yes/No | |

5. Do you have another processor monitoring equipment?_____

_____

_____

Registration # _____

6. Processors

a) X-Ray_____ Hrs. when monitored _____ _____ _____

b) Surgery_____ Hrs. when monitored _____ _____ _____

c) Other_____ Hrs. when monitored _____ _____ _____

_____ _____ _____ _____

7. How much film do you put aside for Q.A.? (at a time)

8. How do you expose Q.A. films?

9. How do you develop Q.A. films?

10. How do you measure densities and where on film?

11. Who set up control charts?_____

a) How were optimum levels and acceptable ranges established?_____

_____

_____

b) Have they changed?_____Yes/No How?_____

_____

12. What is recorded on control chart? (High density, medium density, base plus fog, contrast, speed, temperature, other--give examples.)

13. Has all information (good or bad) been recorded on control chart?

14. Have any adjustments been made on processor because of Q.A.?

Yes/No If so, what?_____

_____

15. Who does maintenance of processor?_____

_____

Registration # _____

16. How often is maintenance performed if routine?_____

_____

17. Has Q.A. had any effect on cleaning of processor or chemistry changes?

18. Are replenishment rates monitored?_____

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

V. Operator and other General Questions

1. Are reject* films kept and evaluated to determine cause? _____Yes/No

2. If you have conducted a formal reject analysis, what was your monitoring period?

_____

3. What is your overall reject rate? _____%

4. Do you have any data on the cost of a retake at your facility?

cost of film
chemicals
machine use
supplies (contrast media, gown, syringe, etc.)
productivity

5. What are your major causes or categories of rejects?

(the following are_____estimated, _____actual)

| | % before started Q.A | % with Q.A. |
|---|---|---|
| too dark | _____ | _____ |
| too light | _____ | _____ |
| positioning | _____ | _____ |
| motion | _____ | _____ |
| technique selection and other operational error | _____ | _____ |
| cone cuts | _____ | _____ |
| blanks or test films | _____ | _____ |
| others_____ | _____ | _____ |
| _____ | _____ | _____ |
| _____ | _____ | _____ |

Registration # _____

6. Do you conduct routine in-house continuing education of your staff? If yes, how do you decide who needs what training?

7. What is the general attitude of the chief tech, radiologist, and staff on the overall quality of films? Has it changed since starting Q.A.?

8. Into what phase of Q.A. related activity are you headed?

9. What QA. activities have been tried and found they do not work or are not worth the trouble?

*Reject films are any discarded radiographs and blank or test films (special procedure areas are usually omitted).

Registration # _____

## VI. Operator and other General Questions

1. Do you do (or have you ever done) any of the following tests? _____

   Does an outside consultant do these tests for you? _____

   Indicate frequency,

   a). Output checks

   Exposure linearity _____

   Exposure reproducibility _____

   b). Timer reproducibility _____

   c). Timer accuracy _____

   d). kVp accuracy _____

   e). Focal spot size and resolution _____

   f). HVL _____

   g). Collimator and beam alignment _____

   h). Photo-timer consistency _____

   i). Film screen monitoring (contact mesh, UV light, etc.) _____

   j). Dark room checks (fog, etc.) _____

   k). Other equipment checks _____

   _____

2. Does each x-ray room have a posted technique chart? Yes/No _____

3. Are the technique charts always used? Yes/No _____

4. Who made up the technique charts? _____

   _____

5. Have you collected any patient exposure data? Yes/No _____

| Exam type | Exposure/exam before Q.A. | Exposure/exam with Q.A. |
|---|---|---|
| i.e. P.A. Skull | 200 mR | 150 mR |
| | | |
| | | |
| | | |

APPENDIX IV (B)
NEW HAMPSHIRE
RADIATION CONTROL AGENCY

Form RCA-X-1

X-ray Inspection Worksheet

Date:_____

A. Facility data

1) Name_____ 4) ZIP_____

2) ID#_____ 5) Type of facility_____

3) City/town_____ 6) Type of practice_____

B. Tube data

1) Room#_____ 2) Mfg_____

3) Tube #_____ Type_____ Workload (Proj/wk)_____

4) Tube #_____ Type_____ Workload (Proj/wk)_____

C. Operator data

1) Operator_____ 2) kVp_____

3) Training_____ 4) Experience_____

D. Projection data

1) Projection_____ 6) kVp_____

2) Workload_____ 7) mA_____

3) Film size_____ 8) Time_____

4) SFD or SCTD_____ 9) mAs_____

5) Measurement distance_____ 10) Beam size_____

11) Detector type & Ser. #_____

| | Raw | C.F. | Corr. |
|---|---|---|---|
| 12) Exp. 1 | | | |
| 13) Exp. 2 | | | |
| 14) Exp. 3 | | | |
| 15) 1.5 or 4.5 | | | |
| 16) Exp. 4 | | | |

17) HVL_____ 18) ESE Calculated_____ Measured_____

E. Fluoroscopic data

1) TTDR @____kVp ____mA
____mR/ ____sec
(R/min) ____

4) Resolution (Lowest kVp, 1 mA)
6"____ or 9"____ image intensifier
Field center_____ Field edge_____

2) STTD_____

3) HVL @ 70 kVp_____

Unshielded LED #____ ____ mR x CF = ____ mR
Shielded LED #____ ____ mR x CF = ____ mR

F. Other compliance data

1) Leakage (max) @____ kVp____

2) Scatter: location_____ rate_____
location_____ rate_____
location_____ rate_____

G. Image receptor data

1) Film: mgf_____ type_____

2) Screen: mgf_____ type_____

3) Grid: ratio_____ lines/inch_____ focused?_____ radius_____

H. Processor Data

1) Auto?____ If yes, mfg_____ model_____

2) Development time (manual)_____

3) Processor time (auto)_____

4) Developer temperature: indicated_____ measured_____

5) Developer chemistry: mfg_____ type_____

I. Personnel monitoring data

1) number monitored_____

2) frequency_____

3) est. avg. exp./period_____

4) number over 300 mR/quarter_____

J. Quality assurance data

| | | mAs | mA | time (dial) | time (meas) | optical density |
|---|---|---|---|---|---|---|
| 1) mAs/timer tool - @ 70 kVp, 40 in.) | a. | ___ | ___ | _____ | _____ | _____ |
| | b. | ___ | ___ | _____ | _____ | _____ |
| | c. | ___ | ___ | _____ | _____ | _____ |

2) Focal spot - @ 55 kVp, 40 in., 3 mAs)

a. source to pattern distance_____

b. source to film distance_____

c. small focal spot size: nominal_____ meas._____

d. large focal spot size: nominal_____ meas._____

3) kVp accuracy

a. phase: single three

b.

| nominal kVp | mAs | | measured kVp |
|---|---|---|---|
| | 1 ph. | 3 ph. | |
| 60 | 150 | 75 | ____ |
| 80 | 90 | 45 | ____ |
| 100 | 20 | 10 | ____ |
| 120 | 6 | 3 | ____ |

c. (multi-mini wedge)

| kVp | mAs (X 2/3) | top step | optical density |
|---|---|---|---|
| ___ | _____ | _____ | _____ |
| ___ | _____ | _____ | _____ |
| ___ | _____ | _____ | _____ |

4) mA station linearity

| mA station (*base) | ratio to base | mR | ratio to base | % error |
|---|---|---|---|---|
| _____ | _____ | ___ | _____ | _____ |
| _____ | _____ | ___ | _____ | _____ |

5) field/beam alignment (70 kVp, 400 mAs, 40 in)

| | | | | | |
|---|---|---|---|---|---|
| field | <1% | <1% | 1%-2% | 2% | >2% |
| beam | <2% | <2% | | | |

NOTE: Timer reproducibility is found by averaging the repeated times used in determining the mA linearity and observing whether or not two standard deviations is within 20% of the mean. By checking two other timer points, a linear regression can be determined to give the actual time for all settings.

*U.S. GOVERNMENT PRINTING OFFICE: 1981-0-341-166/6302

FDA 80-8105 The Selection of Patients for X-Ray Examinations (GPO 017-012-00083-6, $0.50) (PB 80-137431, mf only).

FDA 80-8106 X Rays: So You Have To Be In Diagnostic Radiology?

FDA 80-8107 An Evaluation of Microwave Radiation from Commercial Microwave Ovens (PB 81-[illegible], $5.00).

FDA 80-8108 A Comparative Analysis of the Reduction in Organ Dose in Diagnostic Radiology by Means of Entrance Exposure Guidelines (GPO 017-012-00104-4, $2.75) (PB 80-174876, mf only).

FDA 80-8109 Position Beam Limitation Effectiveness Evaluation (GPO 017-012-00103-6, $2.00) (PB 80-106937, mf only).

FDA 80-8110 Electromagnetic Fields in Thermal Physiology (PB 80-187827, $8.50).

FDA 80-8111 Quality Assurance Programs for Diagnostic Radiology Facilities (GPO 017-012-00102-8, $2.50) (PB 80-133339, mf only).

FDA 80-8112 Get the Picture on Dental X Rays (brochure).

FDA 80-8113 Chest X-Ray Screening Practices: An Assessment Radiography (GPO 017-012-00107-9, $3.50) (PB 80-163899, mf only).

FDA 80-8114 X Radiation and the Human Fetus - A Bibliography (PB 80-137712, $7.50).

FDA 80-8115 A Word of Caution on Tanning Booths (brochure).

FDA 80-8119 Measurements of Emission Levels During Microwave and Shortwave Diathermy Treatments (GPO 017-012-00114-7, $2.75) (PB 80-196771, mf only).

FDA 80-8120 Microwave Oven Radiation (brochure) (supersedes FDA 79-8080).

FDA 80-8121 Laser Light Shows Safety - Who's Responsible? (brochure).

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FDA 80-8123 Guide for the Filing of Annual Reports for X-Ray Components and Systems (PB 80-204597, $5.50).

FDA 80-8126 Optimization of Chest Radiography - Proceedings of a Symposium Held in Madison, Wisconsin, April 30-May 2, 1979 (GPO 017-012-00126-5, $7.50) (PB 80-205317, mf only).

FDA 80-8127 Research into the Biological Effects of Ionizing Radiation in The Bureau of Radiological Health (GPO 017-012-00122-2, $4.00) (PB 80-[illegible], mf only).

FDA 80-8128 Symposium on Biological Effects, Imaging Technologies, and Dosimetry of Ionizing Radiations (July 1980) (GPO 017-012-00123-1, $8.00) (PB 81-112151, mf only).

FDA 80-8127 Guide for the Filing of Annual Reports for [illegible] Subchapter J, Section 1002.11) (PB 80-810099, $6.00).

FDA 80-8128 The Selection of Patients for X-ray Examinations: The Pulmonary Examination (GPO 017-012-00124-9, $2.00) (PB 81-112490, mf only).

FDA 80-8129 Possible Genetic Damage from Diagnostic X Irradiation: A Review (PB 81-101783, $6.00).

FDA 80-8130 Nationwide Survey of Cobalt-60 Teletherapy: Final Report (PB 81-101784, $8.00).

FDA 80-8131 Vignettes of Early Radiation Workers: A Videotape Series (flyer).

FDA 80-8135 Hazards from Broken Mercury Vapor and Metal Halide Lamps (Notice of Alert) (pamphlet).

FDA 80-8140 Reporting Guide for Laser Light Shows and Displays (21 CFR 1002) (PB 81-122212, $5.00).

FDA 81-8027 Directory of Personnel Responsible for Radiological Health Programs (supersedes FDA 80-8027, March 1980).

FDA 81-8090 Bureau of Radiological Health Publications Subject Index (supersedes FDA 80-8090, May 1980).

FDA 81-8136 Optical Radiation Emissions from Selected Sources - Part I - Quartz Halogen and Fluorescent Lamps (GPO 017-012-00127-6, $6.50).

FDA 81-8139 Quality Assurance in Diagnostic Ultrasound - A Manual for the Clinical User (GPO 017-012-00129-2, $4.00).

FDA 81-8140 Diagnostic Ultrasound Reporting Guide (21 CFR 1002.10).